Measuring the Effects of the Changing Demographic Compositions on Vehicle Miles of Travel (VMT) Growth Using the Standardization and Decomposition Techniques

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ABSTRACT

This paper examines the effects of population size and demographic compositions on the change over time of the overall vehicle miles of travel (VMT) growth of the US and the Southern California Association of Governments (SCAG) region between 2005 and 2035 using the standardization and decomposition techniques. Two major data sets (2035 US and the SCAG region's population projections by age, sex, and race/ethnicity and age-sex-race/ethnicity specific VMT) are used. The model results show that the population size change and the demographic composition change of the nation and the SCAG region make an important contribution to the VMT growth in the future. The role of the race/ethnicity composition factor in the regional model is as important as the age composition factor in influencing the change of the VMT per person. The race/ethnicity composition factor in the regional model makes a bigger effect on the VMT growth that that in the US model. The model results show that there is no significant difference in the overall change in the average VMT and the effects of overall demographic factors between the national model and the regional model. There is a major difference in the contribution of both the race/ethnic factor and the sex factor. The race/ethnic factor and the sex factor in the mid scenario of the regional model play a more important role in influencing the overall change in the VMT per person than in the national model. The age factor is equally important in both the national model and the regional model. The level of the future immigration size is also expected to influence the change of the overall VMT via the change of race/ethnic compositions. The paper concludes that the standardization and decomposition techniques are useful tools for measuring the contribution of population size and demographic compositions on the overall change over time of the average VMT. The paper also indicates that we might produce more accurate VMT estimate by incorporating selected demographic factors in the transportation demand forecast model. With an introduction of Assembly Bill 32 and Senate Bill 375 in California, VMT becomes more important performance measure to reduce Greenhouse Gas emissions. Metropolitan Planning Organizations (MPO) in California are searching for more advanced modeling tools (integrated land use-transportation model, activity based model) to accurately measure and project VMT levels. The selected demographic factors might be further tested and included in the traditional/new transportation demand forecast model process to enhance the planning relevance of the projected or simulated VMT levels.

Keywords: population size, demographic compositions, vehicle miles of travel, standardization and decomposition technique

1. INTRODUCTIONS

Socio-economic conditions, land use, and transportation system affect travel behavior and vehicle miles of travel (VMT) via trip rates, trip length, and mode selection (1). As one of socio-economic conditions, the key demographic characteristics of travelers play an important role in determining the VMT growth. There has been little research on the linkage between key demographic characteristics (age, sex, and race/ethnicity) and VMT growth projection. The nation is moving toward a more aging and ethnic diverse region due to lower fertility, lower mortality, and continued immigration.

This paper develops the linkage between key demographic characteristics (age, sex, and ethnicity) and VMT growth projections. The linkage is measured by the age-sex-race/ethnicity specific travel measures. The proposed VMT projection model can be used to understand a wide range of impacts of changing demographic compositions on VMT growth projections. The VMT growth projections from the proposed model can also be used as a reference for assessing the VMT growth projections using trend extrapolation methods or a four step transportation demand forecast model.

The main purpose of this paper is to measure the effects of the size and composition of projected populations on the change over time of VMT growth of the US and the Southern California Association of Governments (SCAG) region between 2005 and 2035 using the standardization and decomposition techniques. The proposed VMT growth projections require two major data sets: long term population projections by age, sex, and race/ethnicity; age-sex-race/ethnicity specific VMT. First, US Census or SCAG developed population projections by age, sex, and race/ethnicity will be used. Second, the historical age-sex-race/ethnicity specific VMT are derived using 1995 national person travel survey (NPTS) or 2001 national household travel survey (NHTS).

The research uses a Rates-Composition analysis to understand the impacts of two components (demographic composition and age-sex-race/ethnicity specific VMT) on the VMT growth projections (2). A change in demographic composition, a change in age-sex-race/ethnicity specific VMT, or a combination of the two affects the VMT growth projections. A range of VMT growth projections will be compared with the VMT growth projections derived from a traditional four step transportation demand forecasting process.

2. VMT GROWTH AND EFFECTS OF POPULATION SIZE AND DEMOGRAPHIC COMPOSITIONS

VMT, one of major travel measures, indicates transportation demand by estimating the overall level of highway and automobile uses, and is directly related to mobile source emissions (3). According to the 2001 NHTS, VMT, including person trips, person miles of travel (PMT), vehicle trips, showed a tremendous increase between 1969 and 2001, while population and household showed a modest growth during the same period (4, 5). For example, the growth rate of US population of 16 years and older between 1969 and 2001 was 52%, while VMT growth rate was 193% during the same period. VMT growth was 3.7 times as fast as that of population growth (See Table 1). The daily VMT per person (16+) also nearly doubled from 15.5 in 1969 to 29.9 in 2001. Daily VMT per person (16+) is derived dividing the number of total daily VMT by the number of persons of 16 years and older.

There is impression that the growth of the VMT per person might play a much more important role in deriving the fast VMT growth than population growth in the last four decades or so. It is not really true. Using the standardization and decomposition technique (6,7,8,9,10), we can quantify the unbiased contribution of population growth (change of the population size) or the change of VMT per person on the growth of total VMT (See the methodology section for more detailed description). Kitagawa’s decomposition approach has strength in terms of “economy and expositional cleanness” (9). Following the Kitagawa’s decomposition approach, the difference in the overall amount of VMT is decomposed into two factors: population size effect and rate (VMT per person (16+) change) effect.

Population size effect always showed a strong influence on the change of VMT, except the period of 1983-1990, between 1969 and 2001(See Table 1). If we look at total VMT growth and effects of changing population size by each period, there is fluctuation in the contribution of the population size on total VMT growth (See Table 2). The role of the changing population size in the VMT growth was biggest in the first two periods (1969-1977 and 1977-1983). The changing population size accounted for 91% and 106% of the VMT growth in each of those two periods. The contribution of population size dropped to 12% in the period of 1983-1990. After that period, the contribution of the population size has increased to 42% in the period of 1990-1995 and 49% in the period of 1995-2001.

[Table 1]
[Table 2]

Although it is clear that population size plays a significant role in the total VMT, there is more need to understand the effects of population size and demographic compositions on the VMT growth, given the fact that US and the SCAG region have experienced major demographic changes (e.g., aging, immigration, and race/ethnic diversification) in the past and will experience them in the future

3. DATA AND METHODS

The study uses three different data sources. First, both 1995 NPTS and 2001 NHTS data are used to assess the contribution of demographic components on the VMT growth between 1995 and 2001. Both 1995 NPTS and 2001 NHTS are the nationwide travel survey data, collected by the U. S. Department of Transportation (11, 12). These two surveys are part of 1969, 1977, 1983, 1990, 1995, and 2001 survey series. A wide range of personal travel behavior data is collected and used to examine the relationship among social and demographic change, land development patterns, and transportation. The NHTS collected travel data from a national sample of the civilian, non-institutionalized population of the United States. A national sample of 1995 NPTS and 2001 NHTS data set includes 42,033 households and 69,817 households, respectively (11, 12).

Second, 2008 national population projections are used to measure the contribution of demographic components on the national VMT growth between 2005 and 2035. 2008 national population projections were developed by US Bureau of Census and released on August 2008. The population projections contain information of the future United States resident population by age, sex, race, and Hispanic origin. The population projections are derived using a cohort-component method. The projections are based on assumptions about future births, deaths, and net international migration (13).

Third, 2008 SCAG population projections are used to measure the contribution of demographic components on the regional VMT growth between 2005 and 2035. 2008 SCAG regional population projections are used to develop the 2008 Regional Transportation Plan (RTP) and adopted by the SCAG Regional Council on May 2008. The regional population projections are based on a cohort component model in the context of an economic-demographic model framework. The population projections are based on assumptions about future births, deaths, domestic in-migration, domestic out-migration, and net international migration (14, 15). The population projections contain information of the future regional population by age, sex, and racial/ethnic origin.

Standardization and decomposition techniques will be used to measure the effects of the size and composition of populations on the VMT growth projections. The standardization and decomposition techniques have been widely used in the field of demography (10 for a comprehensive review of the techniques). The standardization technique is used to fairly compare the overall demographic rates of two or more populations by removing the compositional effects. The direct standardization technique derives the standardized demographic rates using one population composition as the standard. The indirect standardization technique derives the standardized demographic compositions using demographic rates of a certain population as the standard. The results of these standardization techniques are oftentimes questionable and unreliable because of the issue of “arbitrary standard” (8, 10). The choice of a certain rate or population as standard for comparison might result in a biased and unacceptable comparison. To overcome the biased standard issue, the decomposition technique is introduce to standardize and decompose the overall difference in a demographic summary measure (e.g., life expectancy, total fertility rate, growth measures) into the effects of the compositional or rate factors.

This study uses the decomposition technique, originally developed by Kitagawa (6) and later further developed by other demographers (7, 8, 16, 17). Kitagawa (6) successfully eliminated the interaction effects occurring during the decomposition process in the case of only two populations and two factors by using the mathematical approach. The decomposition technique was eventually extended to include two or more factors and presented a list of formulas for different cases. The technique assumes that a particular population as standard and recomputes the overall rates in the populations by replacing their compositions by the compositional schedule of the standard population.

A decomposition technique does not require a complex computational procedure to deal with a couple of factors. As questioned in our study, the contribution of changing population size or VMT per person (16+) to the VMT growth can be calculated using the following formula (8, pp.6-7).

$$TV_{t_1} - TV_{t_0} = (POP_{t_1} - POP_{t_0}) * (\frac{V_{t_1} + V_{t_0}}{2}) + (V_{t_1} - V_{t_0}) * (\frac{POP_{t_1} + POP_{t_0}}{2})$$

Where,

$TV_{t_0} = POP_{t_0} * V_{t_0}$,

$TV_{t_1} = POP_{t_1} * V_{t_1}$

TV=the amount of total VMT,
POP= the number of persons of 16 years and older,
V= the amount of VMT per person of 16 years and older

As seen in the above formula, the first component refers to the standardized population size effect, and the second component refers to the standardized VMT per person effect. The standardization is made possible by using the average of the VMT per person or population size between two time periods.

The decomposition technique involving cross-classified data involves a rate effect, which refers to the differences in the cell-specific rates (8). Our study involves three-factor cross-classification of the population and the VMT per person by age, sex, and race/ethnicity for the Unites States and the SCAG region. The computation procedure is well documented by Das Gupta (8, pp. 65-66). The current study uses DECOMP (Version 0.51), which was developed by Steven Ruggles (18). DECOMP is a general-purpose program designed to do multiple direct standardization and decomposition of differences between two rates following the computation procedure provided by Das Gupta (7).

The study uses the age-sex-race/ethnicity specific VMT per person as a way to project VMT level by age, sex, and race/ethnic group. As table 3 indicates, 2001 NHTS based VMT per person by age, sex, and race/ethnicity clearly shows the different pattern of the VMT per person by those demographic groups. VMT level per person tends to follow the life cycle stage. VMT level per person is relatively low at the youngest age group of 16-24 (high school students or college students), increases its VMT level per person at age group of 25-34 (recent college graduates, new job holder, new householder), reaches the peak of the VMT level per person at age group of 35-54 (family household with children), then decreases over time (pre-retirement, retirement) after the age 55. Sex also plays a role. The VMT level of woman is 43% lower than that of man. The VMT level by race/ethnic group shows a difference. For example, the highest daily VMT level per person is observed from the NH white male group (40.2), followed by NH male others (36.7), Hispanic male (32.8), and NH Black male (29.8).

[Table 3]

Given the volatile nature of the VMT growth pattern, the extrapolation techniques might not be effective in making accurate VMT projections. Probably scenario approach might be more suitable for understanding the possible future VMT for its ‘what-if’ nature. Past studies indicate that the VMT growth rate would slow down in the future. The annual growth rates of VMT would range from 2.1% to 2.5% (19) or 1.5% to 2.0 percent (20), 1.6% to 2.4% (21) at the national level. The recent VMT forecasts of the SCAG region for year 2030 show 2.7% growth rate (22). Three alternative levels (low, mid, high) of the age-sex-race/ethnicity specific VMT per person are used to measure the sensitivity of the changing contribution of demographic factors (age, sex, and race/ethnicity). Three alternative VMT levels include 1) the age-sex-race specific per capita VMT remain constant as of 2005 (low), 2) the age-sex-race specific per capita VMT is 24% higher than that of the 2005 VMT level (mid), which results in 1.7% annual growth rate of total VMT. 1.7% growth rate was once observed from VMT growth in the recent eleven years: 1995-2001 (23) and 2001-2006 (24). 3) the age-sex-race specific VMT per person is 50% higher than that of the 2005 VMT level (high), which results in 2.7% annual growth rate of VMT. 2.7% annual growth rate is based on the weighted average of the annual growth of both 1990-1995 and 1995-2001 (23). The recent growth pattern of 1995-2001 was more weighted than that of 1990-1995. Three different levels of the age-sex-race/ethnicity specific VMT per person are commonly applied to both the US model and the SCAG regional model. They show different results of three scenarios of VMT growth and the effects of demographic components (age, sex, and race/ethnicity).

The SCAG regional model introduces additional scenarios with different amount of immigration to measure its impact on the overall VMT. Immigration scenario is closely linked to the change of race/ethnic composition. Low immigration scenario (60,000 net immigrants per year) is based on the half of the current SCAG immigration assumptions (120,000 net immigrants per year), while high immigration scenario (60,000 net immigrants per year) is based on 50% above the current SCAG immigration assumptions. The reduction or addition of immigrants from the cohort-component model does not significantly affect total regional population due to the regional projection model framework. Since the SCAG regional population is constrained by the projected jobs and the normal unemployment rate (6%), the reduction of immigrants will result in the additional number of domestic in-migrants or the addition of immigrants will lead to the reduction of domestic in-migrants. Through this process, the region will experience dynamic demographic change, including age, sex, and race/ethnic distributions.

4. ANALYSIS

According to population projections recently released by the U.S. Census Bureau, people in the nation will be much older and more racially and ethnically diverse in 2035 (13). Using population projections of 16 years and older, the number of population of 65 years old and more is expected to increase from 15.9% in 2005 to 25.1% in 2035. The working-age minorities, now 30 percent of the U.S. working-age population, are expected to account for approximately 45 percent in 2035. The nationwide pattern of aging and race/ethnic diversification is also occurring in the SCAG Region, but to somewhat different degree (See Table 4). The SCAG region is the second most populated metropolitan area in the United States. Nearly one-half of all Californians live in the SCAG Region, and 1 in 17 people living in the entire United States resides here. By July 1, 2007, the region’s population had reached 18.6 million residents. There is no racial or ethnic majority in the region. Hispanics constitute 44 percent of the region’s population, followed by Non-Hispanic (NH) Whites at 36 percent, NH Asians and Others at 13 percent, and NH Blacks at 7 percent. Since 2000, Hispanics have increased their share of the population by 3 percent, while NH Whites have decreased their share by the same percentage. The region is moving toward a Hispanic majority.

As the region grows, the average person will be older, and Hispanics will become the majority ethnic group (55.9%) in 2035. The population in the region will become older because of aging “baby boomers” born between 1946 and 1964. The median age will rise from 32.9 years in 2005 to 35.9 in 2035. The population aged 65 and older will grow four-and a-half times faster than the working-age population (16-64 years old) between 2005 and 2035. As a result, workers in the region will support a larger share of the older “baby boomer” population in 2035. Due to the retirement of “baby boomers,” the region may experience severe shortages of skilled labor. The aging baby boomers may postpone the retirement or the female labor force may increase the labor force participation. Shifting demographic patterns will also influence travel behavior. For example, the elderly people travel less than the younger population and the elderly workers tend to work at home. If necessary, they commute to work for a shorter distance.

[Table 4]

The annual growth rate of VMT in the US varies across the historical period from 1969 to 2006. While the annual growth rate of VMT remains at approximately 2% in the early periods of 1969 to 1983 and in the later periods of 1995 to 2006, it showed a very high level between 4% and 6% in the middle period of 1983 to 1995. Since 1995, the annual growth of VMT has stabilized at 1.7% (See figure 1). As observed in US, the overall annual growth of VMT in the SCAG region also declines between 1999 and 2006. The VMT growth fluctuates between 1% and 4% during the same period. The most recent statistics of the VMT growth for 2005-2006 shows the growth rate of less than 1% (See figure 2).

[Figure 1]
[Figure 2]

With three different levels of age-sex-race/ethnic VMT level and population projections, both US model and the SCAG Region model produce VMT projections for year 2035 (See Table 5). Daily VMT of US is expected to grow from 6.8 billion VMT in 2005 to 8.3 billion VMT (low scenario), 10.3 billion VMT (mid scenario), and 12.3 billion VMT (high scenario) in 2035, while the SCAG region's daily VMT grows from 380 million VMT in 2005 to 469 million VMT (low scenario), 583 million VMT (mid scenario), and 699 million VMT (high scenario) in 2035. Immigration scenarios of the SCAG region model do not show a big difference of VMT from the mid scenario. The difference is estimated at only +/- 1% of the mid scenario VMT.

[Table 5]

5. RESULTS

The VMT growth between 2005 and 2035 is decomposed into the effects of population size and VMT per person (See table 6). Population size is expected to play a bigger role in the VMT growth between 2005 and 2035 than in the historical period. The effect of population size on the mid scenario VMT growth is 65% during the period of 2005 and 2035, while the effect of population size on the past VMT growth is 48% during the period of 1969-1990 and 44% during the period of 1990-2001. The effect of population size on the VMT growth varies depending on the VMT per person assumption. The lower VMT per person, the higher the effect of the population size on the VMT growth is. The immigration scenarios of the SCAG Regional model also produce the different effect of population size on the VMT growth. The overall difference of the contribution of the population size on the VMT growth between the mid scenario and two migration scenarios (low and high) is +/- 1.5%. The high immigration scenario relatively increases the contribution of the population size on the VMT growth, while low immigration relatively decreases the contribution of the population size on the VMT growth

[Table 6]

Table 7 summarizes the results of the components analysis of the difference between the vehicle miles of travel (per person) for 16 years and older for United States and the SCAG Region. The results include the absolute or relative effects of three demographic components (age, sex, and race/ethnicity) in the change of VMT per person for 16 years an older. The overall change over time of VMT per person is understood as a product of changing demographic compositions (e.g., age, sex, and race/ethnicity) and the changing age-sex-race/ethnic specific VMT level.

[Table 7]

The VMT per person increased by 1.06 points between 1995 and 2001 in the United States. If the age-sex-race/ethnic distributions were identical in both 1995 and 2001, this increase would have been 1.41. If the age-sex-race/ethnic specific VMT level were identical in both 1995 and 2001, this increase would have been -0.35, which are attributable to the demographic compositional changes alone. All of demographic compositional changes accounted for (negative) 35% of the overall difference in the VMT per person between 1995 and 2001. After controlling for other demographic distributions and VMT level, the change of age distribution alone contributed to the decline of 0.17 VMT per person, the change of race/ethnic distribution alone contributed to the decline of 0.16 VMT per person, and the change of sex distribution alone also contributed to the decline of 0.02 VMT per person. During the period of 1995 And 2001, age and race/ethnic factors showed a similar effect on the change of VMT per person, while sex factor showed a minor effect on the change of VMT per person.

When we decompose the change in the overall VMT per person and the effects of changing age, sex, and race ethnic distributions between 2005 and 2035 in the nation, the increase of 3.66 VMT per person of the mid scenario is attributable to age (-1.90), race/ethnic factor (-1.18), and sex factor (-0.07. All of demographic compositional changes accounted for (negative) 86% of the overall difference in the VMT per person between 2005 and 2035. The contribution of demographic factors is much higher than that of 1995-2001. The overall contribution of demographic factors increased from 35% in the period of 1995-2001 to 86% in the period of 2005-2035. Age factor (e.g., aging) is found to affect the change in VMT level 60% more than race/ethnic factor (e.g., ethnic diversity), while sex factor maintains the small effect. This might imply that aging proceeds much faster than the race/ethnic diversification in the nation. Low and high scenarios with different age-sex-race/ethnic specific VMT level show a different contribution of overall demographic factors on the change of the overall VMT per person. Low scenario shows a high contribution of overall demographic factors (100%) on the change of VMT, while the mid scenario (-86%) and the high scenario (-34%) show a relatively smaller contribution.

The increase of 3.17 VMT per person of the mid scenario in the regional model is attributable age factor (-1.51), race/ethnic factor (-1.42), and sex factor (-0.21). All of demographic compositional changes accounted for (negative) 99% of the overall difference in the VMT per person between 2005 and 2035. Both age factor (e.g., aging) and the race/ethnic factor (e.g., ethnic diversity) affect the change in VMT level to the same degree, while sex factor still maintains the small effect. This might imply that race/ethnic diversification proceeds as fast as aging in the nation. Low and high scenarios with different age-sex-race/ethnic specific VMT level show a different contribution of overall demographic factors on the change of the overall VMT per person. Low scenario shows a high contribution of overall demographic factors (100%) on the change of VMT, while the mid scenario (-99%) and the high scenario (-38%) show a relatively smaller contribution.

Immigration scenarios in the regional model affect the relative contribution of the race/ethnic factor to the overall change of VMT per person. Low immigration scenario reduces the race/ethnic contribution of the mid scenario from the negative 45% to the negative 35%, while high immigration scenario increases the race/ethnic contribution of the mid scenario from the negative 45% to the negative 56%. As a result of different immigration scenarios, the overall contribution of demographic factors is also affected. The demographic factors in the low immigration scenario contributed to the change in the overall VMT per person by the negative 87%, while the demographic factors in the high immigration scenario contributed to the change in the overall VMT per person by the negative 113%. The range of the differences in the demographic contributions between the low and high immigration scenarios is 26 percent point.

There is no significant difference in the overall change in the VMT per person and the effects of overall demographic factors between the national model and the regional model. There is a major difference in the contribution of both the race/ethnic factor and the sex factor. The race/ethnic factor in the mid scenario of the regional model explains negative 45% of the overall change in the VMT per person, while the race/ethnic factor in the mid scenario of the national model explains negative 32% of the overall change in the VMT per person. The difference in the contribution of the race/ethnicity factor is 13%. This difference was affected by the degree of how fast the race/ethnic diversification proceeds in the nation and the SCAG region. The similar pattern is found from the contribution of the sex factor. The sex factor in the mid scenario of the regional model explains negative 7% of the overall change in the VMT per person, while the sex factor in the mid scenario of the national model explains negative 2% of the overall change in the VMT per person. The difference in the contribution of the sex factor is 5%. The relatively fast growth of the male population relative to the female population in the region results in such a big difference (5% point).

In summary, first, population size change of the nation and the SCAG region makes an important contribution to the VMT growth in the future. According to the mid scenario of the US model, the projected population size change explains 65% of the VMT growth for the period of 2005-2035. The contribution (65%) of the population size change is generally higher than in the past. The mid scenario of the SCAG regional model, the projected population size change explains 72% of the VMT growth for the period of 2005-2035. Second, demographic composition change factors, in particular, the age factor and the race/ethnicity factor, play an important role in influencing the VMT growth in the future. According to the mid scenario of the US model, the projected demographic change (age, sex, and race/ethnicity) explains the negative 86% of the national VMT growth and the negative 99% of the SCAG regional model for the period of 2005-2035. The contribution (-86%) of the national demographic composition change is much higher than in the period of 1995 and 2001. Third, the role of the race/ethnicity composition factor in the regional model is as important as the age composition factor in influencing the change of the VMT per person. The race/ethnicity composition factor in the regional model makes a bigger effect on the VMT growth that that in the US model. Fourth, the role of the race/ethnic factor is influenced by the change of future immigration size. With the assumption of high immigration size, the role of the race/ethnicity composition factor might increase from -45% of the mid scenario to -56% by 11% point. Fifth, as observed from the past historical pattern of VMT growth at both the national level and the regional level, there is a dramatic change in the overall amount of VMT. Although the future VMT growth is expected to slow down, the uncertainty underlying the future VMT growth. This study came up with three different scenarios of the future VMT level per person, in particular, the age-sex-race/ethnic specific VMT level, to understand the future VMT growth pattern and the effects of demographic components. In this study, the annual average % change of the national (regional) VMT level per person ranges from 0.7% to 2.7% (0.8% to 2.8%). Three different scenarios provided us with a range of the potential contribution of demographic composition changes on the VMT growth.

6. DISCUSSIONS

The study suggests that the change of demographic compositions, in particular, age and race/ethnic composition factors, plays a significant role in the future VMT growth. These demographic variables might have significant implications for the current transportation demand forecast modeling practice. Three model steps (trip generation, trip distribution, and mode choice) in the four step transportation forecast modeling process directly affect the VMT growth. The calibration of these three models usually does not incorporate such demographic factors as input. We might produce more accurate VMT estimate by incorporating such demographic factors in the transportation model.

The incorporation of demographic factors in the transportation model might also help us to develop more relevant land use scenarios. The current practice tends to develop alternative land use scenarios by simply changing land use density, land use intensity, land use mix, or combination of them. For example, the Envision Scenario, an alternative land use scenario for 2008 RTP, is developed by reflecting aggressive smart growth strategies. This Envision Scenario is expected to reduce the VMT of the Baseline Scenario by 5% (See Table 8). Although currently not in place, the integrated land use-transportation approach would measure the induced land development effect of transportation improvements. The induced effect can be translated into the further reduction of the VMT by 15% of the VMT difference between scenarios (25). Also, the 4D approach is sometimes used to measure the proper VMT reductions resulting from using alternative land use strategies. As SCAG's conventional 4-step regional travel model can not fully capture these innovative land use effects on travel behavior, these effects, measured in such dimensions as density, land use mix (diversity), and pedestrian and transit-compatible design, and regional transit accessibility, referred to as 4D, are found to have an important influence on household vehicle ownership, substitution of walking for driving, and reduced trip lengths and VMT. The 4D approach is found to reduce the VMT of the Baseline Scenario by 2.4%. Those two approaches are focused on the alternative land use strategies, not reflecting any demographic change at the small area scale.

[Table 8]

We will experience inconsistency in VMT estimates between NHTS and HPMS. The difference in the survey methods might have caused a gap. For example, the 2008 regional transportation plan estimated the VMT level at 409 million daily VMT in 2003, while the regional model of this study estimates 380 million daily VMT in 2005. The difference is estimated around 6%. There is also discrepancy in VMT projections between the SCAG regional model of the study and the SCAG's traditional transportation demand forecast model. The 2008 regional transportation plan projects the 2035 VMT level at 573 million daily VMT, while the regional model of the study estimates 583 million daily VMT for 2035. The annual average % VMT growth of the region's traditional transportation demand forecast model between 2003 and 2035 is estimated at 1.3%, which is 0.5% lower than that of the regional model of this study. This annual growth rate of the traditional model belongs to the lower category of the SCAG region's annual average % growth of VMT (between 0.8% and 2.8%).

[Table 9]

California has discussed how to respond to the climate change issue in recent few years. California Assembly Bill (AB) 32 was already enacted in 2006 for the purpose of reducing Greenhouse Gas (GHG) to 1990 levels by 2020. California Senate Bill (SB) 375 was proposed to provide a program to implement provisions of AB32 for land use and transportation, and to reduce GHG Emissions for land use and transportation through reduction in VMT, and was signed into the law on September 30, 2008. With an introduction of AB32 and SB375 to effectively reduce Greenhouse Gas emissions in California, VMT becomes more important performance measure. Metropolitan Planning Organizations (MPO) in California are searching for more advanced modeling tools (integrated land use-transportation model, activity based model) to accurately measure and project VMT levels. The selected demographic factors might be further tested and included in the traditional (or improved) transportation demand forecast model process to enhance the planning relevance of the projected or simulated VMT levels.

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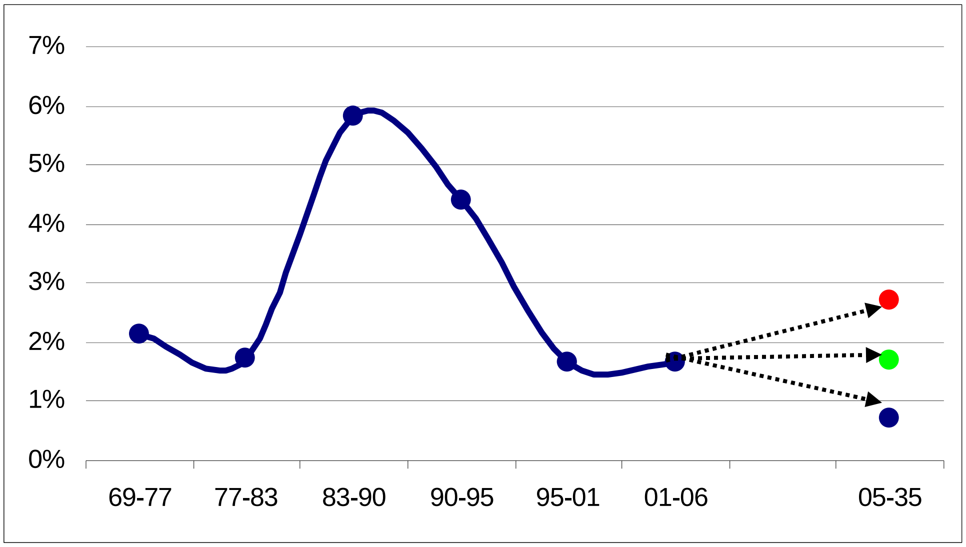
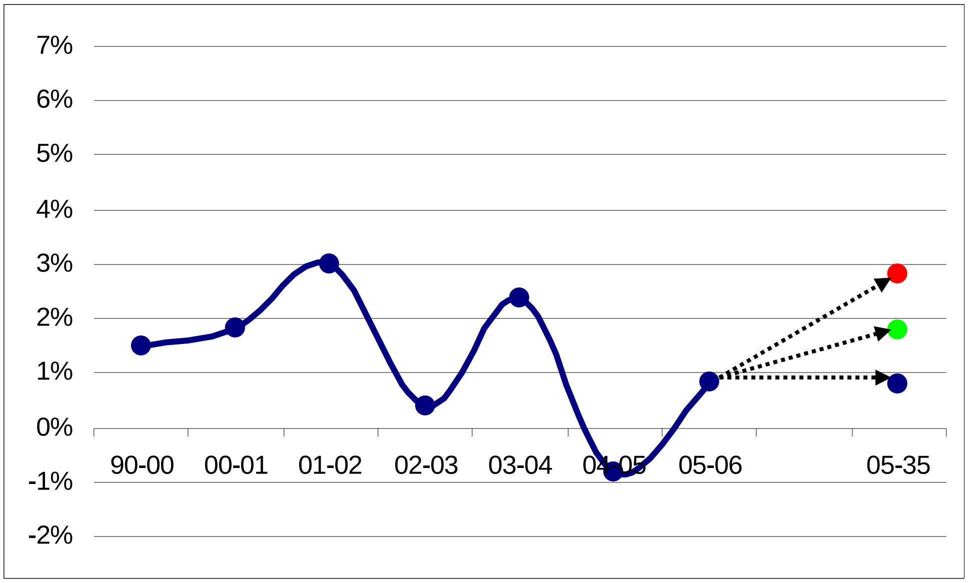


Source: NPTS NHTS Highway Statistics 2001 and 2006.

FIGURE 1. Annual Average VMT Growth Rate of the US: Historical Trends and Projections



Source: dot.ca.gov/hq/tsip/smb/documents/mvstaff/mvstaff07.pdf

FIGURE 2. Annual Average VMT Growth Rate of the SCAG Region: Historical Trends and Projections

TABLE 1. Trends of Population and VMT Growth, 1969-2001

	1969	1977	1983	1990	1990*	1995	2001
Population (16+)(000)	137,113	158,183	175,771	182,803	182,803	198,583	208,155
Daily VMT (000,000)	2,126	2,487	2,746	3,862	4,645	5,667	6,232
Daily VMT per person (16+)	15.5	15.7	15.6	21.1	25.4	28.5	29.9
	69-77	77-83	83-90	90*-95	95-01	69-90	90*-01
Change in Daily VMT (000,000)	361	259	1,116	1,022	566	1,736	1,588
Annual Average % Change	2.1	1.7	5.8	4.4	1.7	3.7	3.1

Note: *1990 person and vehicle trips adjusted.

TABLE 2. Decomposition of VMT Growth: Population Size and VMT per Person, 1969-2001

	69-77	77-83	83-90	90*-95	95-01	69-90	90*-01
Change in Daily VMT (000,000)	361	259	1,116	1,022	566	1,736	1,588
Population Size Effect (000,000)	329	276	129	326	506	837	702
Rate Effect (000,000)	32	-17	987	457	516	899	886
Change in Daily VMT (%)	100	100	100	100	100	100	100
Population Size Effect (%)	91	106	12	42	49	48	44
Rate Effect (%)	9	-6	88	58	51	52	56

Source: NPTS (1969, 1977, 1983, 1990, 1995) and NHTS (2001)

TABLE 3. VMT Per Person for 16 Years and Old More by Age, Sex, and Race/Ethnicity, 2001

Age	Male					Female					Total
	Hispa nic	NH White	NH Black	NH Other s	Total	Hispa nic	NH White	NH Black	NH Others	Total	
16-24	17.9	28.4	15.4	26.1	25.1	11.2	23.2	15.7	18.2	19.7	22.5
25-34	39.3	42.3	41.5	36.0	41.3	17.0	27.2	24.2	20.3	24.7	32.9
35-44	43.0	46.6	39.5	39.3	45.0	20.2	30.0	26.4	24.2	28.0	36.4
45-54	32.8	48.5	33.2	46.4	45.6	18.8	27.0	25.3	23.4	26.0	35.4
55-64	34.8	43.2	23.4	42.4	40.8	12.7	20.8	16.0	12.7	19.4	29.7
65-74	21.5	34.1	20.9	37.4	32.2	7.2	12.7	8.8	14.2	12.0	20.9
75-84	4.5	23.6	6.3	8.8	21.1	2.1	8.1	2.7	5.2	7.3	13.0
85+	2.9	10.4	6.0	2.4	9.5	0.1	3.1	0.0	0.3	2.5	4.9
Total	32.8	40.2	29.8	36.7	38.2	15.5	23.1	19.6	19.1	21.6	29.6

Source: NHTS (2001)

TABLE 4. Frequency Distribution of the Population of 16 Years and Older by Factors, 1995-2035: United States and the SCAG Region.

	Nation				SCAG Region			
	1995[1]	2001[1]	2005[2]	2035[2]	2005[3]	2035[3]	2035 LM[4]	2035 HM[4]
Age Group								
16-24	15.2	15.0	16.3	14.9	18.3	15.8	15.3	16.4
25-34	21.9	19.6	17.2	16.0	19.4	17.7	17.3	18.1
35-44	21.3	20.9	18.9	15.7	19.7	16.9	16.7	17.1
45-54	15.6	17.1	18.4	15.2	17.3	15.2	15.3	15.1
55-64	10.3	11.6	13.2	13.2	11.8	12.8	13.1	12.6
65-74	9.8	8.9	8.1	12.3	7.1	11.1	11.4	10.7
75-84	4.7	5.5	5.7	9.1	4.7	7.7	8.0	7.4
85+	1.2	1.4	2.1	3.7	1.7	2.7	2.8	2.6
Sex								
Male	48.2	48.2	48.6	48.7	49.1	49.9	49.9	50.0
Female	51.8	51.8	51.4	51.3	50.9	50.1	50.1	50.0
Race/Ethnicity								
Hispanic	9.3	11.6	12.6	22.6	38.3	52.7	49.4	55.9
NH White	74.7	72.2	69.7	55.6	40.5	25.6	28.5	22.6
NH Black	11.5	11.4	11.6	12.1	7.2	6.8	7.2	6.3
NH Others	4.4	4.8	6.0	9.7	14.1	15.0	14.9	15.1
Total	100	100	100	100	100	100	100	100

Note: 1. data are based on 1995 NPTS and 2001 NHTS 2. US Census population projections. 3. SCAG population projections. 4. LM: low immigration scenario, HM: high immigration scenario.

TABLE 5. Population and VMT Projections

	US				SCAG Region					
	2005	2035			2005	2035				
Scenario		Low	Mid	High		Low	Mid	High	LM	HM
Population (16+)(000000)	230	309	309	309	13.8	19.1	19.1	19.1	19.1	19.0
Daily VMT (000,000)	6,788	8,250	10,250	12,287	380	469	583	699	589	578
Daily VMT per person (16+)	29.5	26.7	33.2	39.8	27.4	24.6	30.6	36.7	30.8	30.4
Regional Share of Daily VMT					5.6%	5.7%	5.7%	5.7%	5.7%	5.6%
		2005-2035				2005-2035				
Change in Daily VMT (000,000)		1,461	3,462	5,498		90	204	319	209	198
Annual Average % Change		0.7	1.7	2.7		0.8	1.8	2.8	1.8	1.7

TABLE 6. VMT Growth and Effects of Population Size and VMT per Person: United States and the SCAG Region, 2005-2035

	US			**SCAG Region**				
Absolute Effect	2005-2035			2005-2035				
Scenario	Low	Mid	High	Low	Mid	High	LM	HM
Change in Daily VMT (000,000)	1,461	3,462	5,498	90	204	319	209	198
Population Size Effect	2,219	2,253	2,349	123	147	159	157	150
Rate Effect	-758	1,210	3,149	-33	56	160	52	48
Relative Effect								
Change in Daily VMT (%)	100	100	100	100	100	100	100	100
Population Size Effect (%)	152	65	43	137	72	50	75	76
Rate Effect (%)	-52	35	57	-37	28	50	25	24

TABLE 7. Decomposition of the Difference between the Vehicle Miles of Travel per Person for 16 Years and Older: United States and the SCAG Region

	US				SCAG Region				
Absolute Effect	1995-2001	2005-2035			2005-2035				
Scenario		Low	Mid	High	Low	Mid	High	LM	HM
Total Effect	1.06	-2.80	3.66	10.25	-2.80	3.17	9.25	3.39	2.96
Effects of Factors									
Age	-0.17	-1.69	-1.90	-2.11	-1.35	-1.51	-1.68	-1.56	-1.47
Sex	-0.02	-0.06	-0.07	-0.08	-0.19	-0.21	-0.23	-0.21	-0.21
Race/Ethnicity	-0.16	-1.05	-1.18	-1.31	-1.26	-1.42	-1.57	-1.17	-1.65
Combined Effect of Factors	-0.35	-2.80	-3.15	-3.50	-2.80	-3.14	-3.49	-2.94	-3.33
Rate Effect	1.41	0.00	6.81	13.75	0.00	6.31	12.73	6.33	6.29
Relative Effect	1995-2001	2005-2035			2005-2035				
Scenario		Low	Mid	High	Low	Mid	High	LM	HM
Total Effect	100%	100%	100%	100%	100%	100%	100%	100%	100%
Effects of Factors									
Age	-16%	60%	-52%	-21%	48%	-48%	-18%	-46%	-50%
Sex	-2%	2%	-2%	-1%	7%	-7%	-3%	-6%	-7%
Race/Ethnicity	-15%	38%	-32%	-13%	45%	-45%	-17%	-35%	-56%
Combined Effect of Factors	-33%	100%	-86%	-34%	100%	-99%	-38%	-87%	-113%
Rate Effect	133%	0%	186%	134%	0%	199%	138%	187%	213%

Sources: NPTS (1995), NHTS (2001), US Census Population Projections, SCAG Population Projections

TABLE 8. Description of the 2008 RTP Growth Scenarios

Scenario Name	Scenario Description
Baseline	The Baseline scenario represents the most likely growth and growth distribution of the region in the absence of the explicit regional policies. The existing local policies including zoning and general plan are reflected in growth distribution. The most up-to-date local input forms the foundation of the Baseline Growth Scenario.
2004 RTP Update	The 2004 RTP Update Scenario is developed by technically updating the 2004 RTP Plan Forecast with the most recent demographic and economic development trends at city, county, and regional levels.
Plan	The Plan Scenario reflects a less aggressive application of the Compass principles than seen in the Envision scenario. It relies heavily on focusing growth toward centers, transit oriented development (TOD) areas and more utilization of mixed-use development.
Envision	This scenario reflects a combination of the following TOD and Centers strategy increasing in housing capacity. Housing growth was redistributed manually to take advantage of the higher capacity areas. Growth was removed from areas with long commutes (50 miles and greater) and from single-use areas. The TOD strategy resulted from assigning greater capacity to areas around transit stations. Mathematical redistributions were made to move housing from areas with long commutes to the newly found capacity of the TOD areas. The Center strategy resulted from assigning greater capacity to areas in and around regionally significant employment centers. Mathematical redistributions were made to move housing from areas with long commutes to the new found capacity areas.

TABLE 9. VMT Projections for the 2008 RTP Growth Scenarios

	2003	2035			
	Base Year	Baseline	04RTP Update	Plan	Envision
Daily VMT* (000,000)	409	573	566	552	547
Annual Average % Change		1.3%	1.2%	1.1%	1.1%
Daily VMT (per person, 16+)	29.5	30.0	29.7	29.0	28.7
% Change, 2005-2035		1.8%	0.6%	-1.8%	-2.8%

Note: *VMT is estimated from the trips of light, medium, and heavy duty vehicles
Source: Results of the SCAG Regional Transportation Demand Forecast Model.